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Fifth Biennial Meeting of States to Consider the Implementation of the Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects
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Recent developments in small arms and light weapons manufacturing, technology and design and implications for the implementation of the International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons

Report of the Secretary-General

Summary

Since the adoption in 2005 of the International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons, new weapon design and production methods have emerged that could have consequences for international efforts to address the illicit trade in small arms. Those include the use of non-traditional materials, such as polymers, and modularity in weapon design. Specifically, the marking, record-keeping and tracing of small arms is affected by new technology applications, such as laser markings, microstamping, automatic information and data collection and tracking technologies. Many of those technologies have the potential to profoundly influence the way weapons are marked and traced, as well as how records of weapons are kept. The present report indicates the main new trends and innovations in small arms manufacture and design and evaluates them with respect to the purposes and principles of the International Tracing Instrument. As requested by Member States, the report then identifies possible parameters to take into account when considering the adoption or provision, through international cooperation and assistance, of such technologies.

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I. Mandate

1. In annex II to the outcome document of the Second United Nations Conference to Review Progress Made in the Implementation of the Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects (A/CONF.192/2012/RC/4), endorsed by the General Assembly in its resolution 67/58, Member States requested that the Secretary-General submit an initial report, drawing on the views of States, for their consideration at relevant future meetings on the implications of recent developments in small arms and light weapon manufacturing, technology and design for effective marking, record-keeping and tracing; on practical steps to ensure the continued and enhanced effectiveness of national marking, record-keeping and tracing systems in the light of such developments; and on relevant practices in relation to international assistance and capacity-building, including ways to support the transfer, uptake and effective utilization of relevant tools and technologies.

2. The present report was informed by the views of Member States as well as consultations with an array of experts from academia, research institutes and industry.

II. Introduction

3. The aim of the present report is to provide an overview of the trends and challenges that could facilitate further discussion among States Members of the United Nations at the Fifth Biennial Meeting of States to Consider the implementation of the Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects, to be held in New York from 16 to 20 June 2014.

4. New technologies in small arms manufacturing and management are often established technologies with a history of application in other industries. For instance, existing technologies such as radio frequency identification and laser technology have only recently been applied in the context of small arms.

5. It is therefore not surprising that the range of small arms-related technologies that could be classified as new developments is quite wide. The present report will focus only on technology that could have implications on the marking, record-keeping and tracing of small arms or that could potentially affect the implementation of the Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects and the International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons, and the aim of those two instruments to address the illicit trade in small arms and light weapons.

6. Section III of the report contains a presentation of key new trends in small arms and light weapons technology, including the use of new materials in the manufacture of weapons; new concepts in design, such as modularity; and new methods of weapons production, in particular 3D printing. Each of those will be examined in terms of its implications with respect to the commitments under the Programme of Action and the International Tracing Instrument. Section IV of the report includes recent developments in technology applications for weapon marking, record-keeping and tracing. Those include laser technology applications for

marking; automatic identification and data collection technology applications for record-keeping and stockpile management; and technologies that support weapon tracking using global positioning system (GPS) applications in monitoring weapon shipments.

7. Section V contains an examination of new types and applications of technologies, as well as an initial assessment of practical issues that could be considered in applying the technologies examined in section IV in the national context, but also within the framework of international assistance.

III. Recent trends in small arms and light weapon manufacturing, technology and design

8. Recent trends in small arms manufacture technology and design can be divided into three categories: (a) the use of new materials; (b) new concepts in design; and (c) new methods of weapon production, particularly the advent of 3D weapon printing.

A. Materials

9. Until the third quarter of the twentieth century, small arms were generally made of steel (commonly high-carbon and heat-treated), wood and Bakelite, a liquid resin. Wood and Bakelite were used for manufacturing non-essential parts, such as handgrips and buttstocks, with all other parts typically made of steel. Since then, aluminium, titanium and other metals have come into use, and plastics were introduced in the late 1970s and early 1980s for making shells and receivers. In recent years, metal has been increasingly replaced by plastics or polymers in the production of firearm frames and receivers. Polymers provide such advantages as lower cost, lighter weight, resistance to moisture, ergonomic design and thermal neutrality. However, they offer less tensile strength than steel or aluminium and are potentially more susceptible to accidental damage.

Implications for marking under the International Tracing Instrument

10. With the advent of a greater range of materials used to manufacture weapons, the durability of markings should not be compromised. With more materials to choose from in the design phase, producers should be careful to select the most fitting marking technology for each material, maintaining the highest standards in permanence and indelibility.

11. For weapons made of polymers, such markings as manufacturer name and logo can be applied directly in the cast or mould at the time of manufacture, but serial numbers cannot be included in the cast since each weapon requires a unique serial number. Because of the physical characteristics of polymers, traditional stamping methods of weapon marking cannot be used once the weapon is assembled, leaving laser marking or, with some limitations, micropercussion (or dot peen stamping) as suitable marking solutions. With the latter, markings are applied by deforming the surface either by compression or using a hardened punch that prints a series of individual dots to reproduce alphanumeric characters. A possible alternative for

marking polymer weapons is to add a metallic insert in the main plastic component, on which additional markings could be added (see para. 22).

B. Design

12. Modularity has quickly become a feature of military-style weapons. Until recently, military small arms configuration had been fairly straightforward, with each model of weapon having one calibre, one design and one configuration. While it was possible to add accessories to the weapons, these did not change the fundamental technical configuration.

13. Currently, the wide spectrum of operational needs for which armed forces are prepared has led to the development of modular weapons design for military rifles. A rifle can now consist of a core section, primarily the upper receiver, onto which can be attached an array of other parts to obtain different configurations suited for different purposes or missions.

Implications for the implementation of the International Tracing Instrument

14. The fact that modular weapons can be fitted with different components, including from other weapons, could result in different serial numbers appearing on different parts of the same weapon, increasing the risk of misidentification. Indeed, some Member States, in their contributions to the present report, are of the view that the development of modular weapons systems and the increasing use of polymer components pose new challenges for effective marking.

15. Another main challenge presented by modularity is the possibility to change a weapon's calibre, a fundamental characteristic for its identification. In such cases, the same serial number can be associated with two different calibres. However, it could also be maintained that a modular weapon found with more than one serial number actually provides more potential clues to enable a successful trace. In this connection, it is important to note that paragraph 10 of the International Tracing Instrument prescribes the application of a unique marking to an essential or structural component of the weapon, such as the frame and/or receiver, and also encourages the marking of other parts of the weapon, such as the barrel and/or slide or cylinder.

C. Production

16. Originally, 3D printing, or "additive manufacturing" technology, has been used mainly in architecture, industrial design and biotechnology. To perform a print, a machine reads the design from a 3D-printable file and lays down successive layers of liquid, powder, paper or sheet material to build the model from a series of cross sections. These layers are joined or automatically fused to create the final shape. After manufacturers mastered the production of small arms made of polymers, it was a small step to use 3D printing to produce such weapons. Now, even 3D printing using metals is an option.

17. Specialized, high-end 3D printers have an associated cost that, at present, would put them out of reach of most individuals. However, technological improvements will likely decrease the cost of high-end 3D printers. Likewise, the

development of new materials for use in 3D printing could allow for the future use of these materials with lower-end printers.

Implications for the illicit trade in small arms and light weapons

18. 3D printing is a significant innovation in small arms manufacturing, potentially opening up the market to new sectors and actors. Of particular concern with respect to the illicit trade in small arms and light weapons is the availability of this technology for criminal and terrorist activities. At the moment, weapon theft or purchase on the illicit market may require less effort that printing an effective, reliable weapon. But this could change: once production costs decrease and quality increases, 3D printing may become a lucrative alternative for small-scale illicit weapon manufacturing and sale in the future.

IV. Recent developments in technology applications for weapon marking, record-keeping and tracing

19. Beyond new developments in the materials, design and production of weapons, there have also been technological developments that potentially enhance weapon marking, record-keeping and tracing. These include: (a) laser technology applications for marking; (b) automatic identification and data collection technology applications for record-keeping; and (c) the use of global positioning systems in the tracking of weapon shipments.

A. Laser technology

20. Paragraph 8 of the International Tracing Instrument requires that unique markings are applied to small arms and light weapons at the time of manufacture, including the name of the manufacturer, the country of manufacture, the serial number or any alternative unique user-friendly marking with simple geometric symbols in combination with a numeric and/or alphanumeric code, which would permit ready identification by all States of the country of manufacture. The Instrument also requires, to the extent possible, that appropriate simple markings be made on each imported weapon that will permit the identification of the country of import and, where possible, the year of import.

21. The use of laser technology permits the marking of all kinds of surfaces through burning by oxidization. As there is no physical contact between the tool used to make the marking and the object to be marked, this technology can be used on a large spectrum of parts and components, including very small ones.

22. Although polymer materials cannot be marked using traditional stamping, laser markings can be applied that do not damage the structure of polymers. This method is therefore a possible option for small arms with key polymer parts. Some manufacturers prefer to mark polymer weapons by embedding a metallic insert in the main plastic component, on which additional markings can be added.

Implications for the implementation of the International Tracing Instrument

23. Illicit owners of small arms frequently attempt to erase the serial number of weapons. Obliterated markings originally made by stamping in steel can often be

recovered using acid etching, as the original marking usually leaves a trace beneath the surface of the steel, invisible to the eye. Laser marking often leaves no deformations of the crystalline structure of the material, be it polymer or steel. Obliterated laser engravings are therefore more difficult to recover. Relief polishing and reflected light stereomicroscopy can, in certain cases, successfully reveal obliterated serial numbers originally marked by laser.

B. Micro-stamping

24. High-precision micromarks have the advantage of not being easily detectable for those wishing to erase them and can be applied at locations on a weapon where they will be difficult to erase. Moreover, by micromarking the firing pin of a weapon, an imprint can be made on each fired cartridge that could aid forensic evidence collection for criminal investigation.

Implications for marking, record-keeping and tracing

25. The International Tracing Instrument requires markings to be clearly visible on weapons. Microstamping, whether on the weapon itself or by imprinting the cartridge from markings on the firing pin, can therefore only be a method used in addition to the traditional, visible weapon markings. With the advent of modular weapons, the additional micromarking of parts and components may considerably enhance traceability.

26. Microstamping technology, when applied on the firing pin, provides a possibility of identifying a weapon through a recovered cartridge only, that is, without the need to be in possession of the weapon itself. This may be an important addition to weapon-tracing options.

C. Technologies for stockpile management

27. Barcodes, radio frequency identification and biometrics, for example, finger print recognition, all come under the umbrella of automatic identification and data collection technology. Such methods automatically identify objects, collect data on them and enable data to be entered automatically into record-keeping systems. Recently, such technologies have been adapted to a range of applications related to small arms and light weapon stockpile management so as to improve identification, safety and tracking.

1. Barcodes

28. A barcode encodes information in a visual pattern that a machine can read and store. A barcode reader, which consists of a light source, a lens and a light sensor, analyses the barcode's image data and sends the barcode's decoded content to a computer.

2. Radio frequency identification

29. Radio frequency identification technology has two main components: a tag or label, embedded in the weapon, and a separate reader. The tags transmit data to the reader, which converts the radio waves to readable data. In this way, it is similar to

barcoding in that data from a tag or label is captured by a device that stores the data in a database. The tags have an advantage in that they can be read from locations on the weapons outside the line of sight, whereas barcodes must be accessible by an optical scanner.

30. Token-based applications using radio frequency identification require the user to carry an additional physical item, such as a ring, watch, card, or bracelet, to enable the system to operate. These tokens may be carried or worn by an authorized individual. Such token technologies enable a communication channel between the specific weapon and its matching token. In the case of a non-match, the weapon's firing mechanism will not be enabled.

3. Biometric technologies

31. Biometric technologies use the unique features of individuals as the key to identify authorized users. Examples of biometric technologies, which can be applied in arms manufacturing, include the recognition of an individual's fingerprint, palm print, voice, face or dynamic grip on a weapon. Electronic sensors or readers are used to collect biometric data and compare them with those of authorized users stored in a computer memory. With fingerprint technologies, users place their finger on a sensor to initiate authorization. The reader is typically placed in an area on the weapon that is easily accessible with little or no conscious effort by the user, such as on the grip where the finger normally rests. Once the fingerprint is scanned, it is compared with an internally stored list of fingerprints of authorized users. If a match is found, the firearm is enabled; otherwise, it remains locked.

Implications for the implementation of the International Tracing Instrument

32. According to paragraph 7 of the International Tracing Instrument, all marks required are on an exposed surface, conspicuous without technical aids or tools, easily recognizable, readable and durable and, as far as technically possible, recoverable. In the view of some Member States, advancements in weapons manufacture may make it harder to identify serial numbers on weapons. Automatic identification and data collection technologies cannot replace traditional marking requirements under the Instrument. However, such technology may significantly augment traditional marking systems for weapons identification.

33. This technology allows information to be identified and data to be entered directly into computer systems with little or no human intervention, making it particularly suited to record-keeping applications within or across stockpiles. Some Member States expressed the view that such technology could be used to manage small arms in an integrated manner, and reported that there were already pilot-tested radio frequency identification tags on some firearms. Other Member States indicated that opportunities should be explored for the further development of marking and tracing technologies, including those allowing for the remote localization of weapons, time limits or remote manipulation of their functioning, in order to counter high risks of diversion or misuse.

34. Some automatic identification and data collection technologies, while potentially highly useful for enhancing national stockpile management, have limited use for weapon identification across borders. Barcodes or radio frequency identification tags can only be read with accompanying external devices. Weapons found outside the area of their last legal use may not be accompanied by the relevant

devices. This needs to be taken into account in decisions to apply such technology. Each country can set its own rules concerning the frequency allocation for radio frequency identification tags, and not all radio bands are available in all countries. To address international trade concerns, it is necessary to use a tag that is operational within all of the international frequency domains. No standard has yet become as universal as the barcode.

35. User authorization applications of automatic identification and data collection technology limit the use of arms to a selected individual or group of individuals. For the purposes of the International Tracing Instrument, these applications have the potential to take record-keeping, particularly of active stockpiles, to a more advanced level. For example, by automatically recording the moment when weapons are taken out of a facility by specific personnel, it is possible to significantly enhance stockpile accounting and security.

36. Furthermore, arms storage devices and containers are now available whereby weapons can only be removed after entering a code number or scanning a fingerprint, or by way of a radio frequency identification application. In this way, it is possible to track and document which individual has used which specific weapon, when and for how long.

37. Similarly, portable gun locks can be inserted into the barrel or cartridge chamber of weapons and digitally locked to ensure secure storage or transport.

D. Weapons tracking technologies

38. There exist a number of tracking systems for all kinds of commodities. Some, like automatic identification and data collection technologies, collect data using a reader and can therefore only be used in specific locations. Others, like global positioning systems (GPS), employ satellite navigation and allow for the global tracking of items.

39. A GPS receiver locates satellites and, on the basis of distance calculations, deduces an item's location. For effective calculation, a clear line of sight to four or more satellites is required. Originally designed for military use, there are now wide civilian uses for GPS.

40. GPS technology has been used for the discreet monitoring and tracking of shipping containers carrying weapons, which can provide data on an opened door or vibrations from a break-in attempt. Sustained information on the location of such containers makes it harder to steal or covertly reroute them.

Implications for the International Tracing Instrument

41. According to paragraph 5 of the International Tracing Instrument, tracing is the systematic tracking of illicit small arms and light weapons found or seized on the territory of a State from the point of manufacture or the point of importation through the lines of supply to the point at which they became illicit. Tracking the geographic location of weapon shipments is a different type of tracing activity that may complement the Instrument. It is of relevance in particular in the context of improving arms export control systems.

V. Practical steps for the continued and enhanced effectiveness of national marking, record-keeping and tracing and international assistance and capacity-building, including the transfer, uptake and effective utilization of relevant tools and technologies

42. The present section places the abovementioned new technologies in the framework of normative and technical considerations and considers the practical steps required for their implementation, including in the context of international assistance.

Strategy for the acquisition and implementation of technology

43. National choices for the acquisition and application of weapons-related technologies ideally derive from clear priority-setting in a country's national action plan on small arms. Where one government would focus on improving national record-keeping practices by putting in place automatic identification and data collection technologies, another might identify the laser marking of its stockpiles as the most pressing activity. A well-planned strategy would pay careful consideration to which stakeholders need to be engaged to render the applications of the technology a success and which processes are affected by each technology.

44. While all governments may struggle from time to time with the smooth integration of new technologies in their procedures, developing countries may face added challenges. In developing countries, technology acquisition often amounts to importing devices and programmes and adapting these to domestic circumstances. Middle-income developing countries may have more capacity to absorb foreign technologies and perhaps even to duplicate these where appropriate. The least developed countries or those in or emerging from conflict often struggle with such integration processes. In these situations, there is a real danger of technology acquisitions not being used. At the same time, bridging the technology divide instead of widening it should be a shared endeavour. This means that particular attention should be given to building a functioning regulatory and administrative environment in which required new technologies can be successfully embedded. In other words, with respect to policies and practices for the application of technology, there is not one solution that would suit all needs.

45. It is important for policy to be developed and assistance provided on the basis of existing developmental realities, including adequate infrastructure and the availability of human resources. Most importantly, decisions concerning the acquisition of new technologies should take into account how these will interface with the existing and potential future technologies of relevant institutions. For instance, acquiring weapons fitted with radio frequency identification may require an overhaul of existing procedures and support technology.

Assessing requirements

46. The key components of any strategy to integrate new weapons-related technology into a government agency include an assessment of needs, the current state of technology and whether the new technology is indeed required. Here, it is important to assess if the current technology is out of date for reaching the goals set.

47. Acquisition decisions should be made on the basis of not only business needs and record-keeping capabilities, but also suitability and whether the new technology can evolve with changing requirements. For instance, in cases where there is frequent personnel rotation, a technology that uses external tokens or identification codes for authentication may be more practical than biometric technologies.

48. New technology should be applied in areas other than the purchase of new weapons. The first step in addressing the illicit trade in small arms must be towards the illicit weapons that are already in circulation around the world; new technology should therefore include the possibility of retrofitting weapons that already exist in national stockpiles, for instance, with new features that enhance tracking and management.

Acceptability and applicability

49. When considering the purchase or transfer of technology, it is important to consider the acceptability of recurring costs, including electricity, fuel transport, maintenance, spare parts and personnel.

50. Other non-material acceptability considerations may include the compliance of the technology with national regulations and with regional and global instruments and commitments. For example, as mentioned above, automatic identification and data collection technologies may supplement marking requirements under the International Tracing Instrument, but would not replace them.

51. In terms of applicability, the considerations are more technical in nature and may include questions related to the durability of the technology, if the technology affects the integrity or functionality of the weapon or if weapon markings can be easily obliterated.

Implementation of the technology

52. Implementing a new technology nationally can be a large task that could be piloted first at an appropriate facility. During the pilot phase, operating problems and logistical challenges could be reviewed and potentially solved before the full-scale implementation of the technology. Personnel training and on-the-job monitoring in a pilot phase could also help to address common issues and questions posed by staff before the wider deployment of the technology. After its full-scale implementation, a regular review of the use of the technology may also be useful.

Sustainable assistance

53. Technological advances tend to increase complexity and uncertainty, make end users dependent on specialized experts and build new knowledge hurdles for potential adopters of technology. Knowledge and technical know-how can become barriers to the diffusion of new technologies. To help overcome such hurdles, a contract between donor and recipient entities could go beyond the provision of equipment.[1] Facilitating the transfer of knowledge is a key element in developing a sustainable approach to assistance. For instance, after the provision of automatic identification and data collection technology to a recipient country, it is paramount

[1] Hee Jun Choi, "Technology Transfer Issues and a New Technology Transfer Model", *The Journal of Technology Studies*, Fall 2009, Vol. 35, No. 1. Available from http://scholar.lib.vt.edu/ejournals/JOTS/v35/v35n1/choi.html.

that in-house expertise be made available in the event that a barcode reader or other technology should malfunction. Developing such sustained in-house expertise, and agreeing on the provision of external expertise and services as an interim measure, can be part of a technology transfer arrangement.

VI. Conclusions and recommendations

54. Evolutions in weapons manufacturing and design technology, such as the use of polymer frames, modularity and 3D printing, pose increasing challenges for the marking and identification of weapons. The potential for illicit manufacture of weapons using 3D printing also exists. The ramifications of these developments in terms of implementation of the International Tracing Instrument may be addressed at the Fifth Biennial Meeting of States to Consider the Implementation of the Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects and other meetings under the Programme of Action.

55. Technologies that could enhance effective marking, record-keeping and tracing are becoming increasingly available and should be selected after careful consideration of the context and capacities of the technological, regulatory and service environment in which the new applications will become functional.

56. As a result of such an assessment, which could be undertaken at the national or regional level, the retrofitting of existing weapons with new technologies could be a valuable measure for addressing the challenge of existing weapons at risk of diversion.

57. When new acquisitions of arms become inevitable, selecting weapons equipped with newer technological applications will help to diminish the dangers of weapons becoming unaccounted for, provided that the appropriate record-keeping and other weapons management procedures are in place.

58. Where assistance and cooperation on these matters is planned, donor and beneficiary States may wish to make use of a set of guidance parameters for the transfer of equipment, covering such areas as the sustainability of the assistance, including such recurring costs as training, electricity and fuel, and whether regional harmonization, that is, the provision of compatible equipment, should be considered.

59. Regional groups of States interested in using these technologies are encouraged to discuss collectively the possibilities and limitations of the technologies and may choose to develop a harmonized regional approach. The United Nations regional centres for peace and disarmament stand ready to support such efforts where needed.

60. The International Tracing Instrument is a highly valuable global agreement on a topic with considerable technological implications. To ensure its continued relevance, the Instrument could be strengthened by taking into account new developments in technology to enhance weapon marking, record-keeping and tracing. If this principle is broadly supported, Member States may wish to discuss the possible value of agreeing on a document supplementary to the Instrument, such as an annex, which would reflect the implications of recent technical developments in the marking, record-keeping and tracing of small arms. The agreed schedule of meetings under the Programme of Action may guide such discussions. For instance,

the 2015 meeting of governmental experts would be an opportunity to hold a focused expert discussion on the topic and to identify the main elements of such a supplementary document. Subsequently, the agreement could be finalized at the Sixth Biennial Meeting of States, to be held in 2016.